

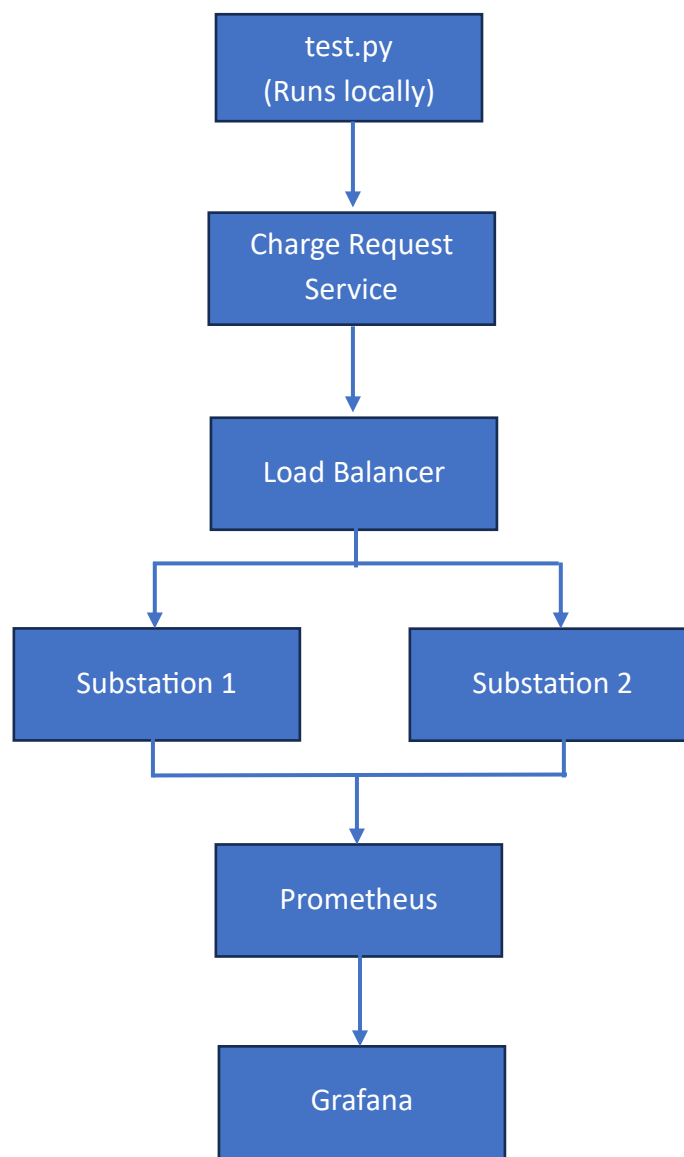
# Project Report

## Part 2

### Dynamic Load Balancing for a Smart Grid

In this assignment the objective is to design and build a scalable system for a Smart Grid that dynamically balances Electric Vehicle (EV) charging requests across multiple substations based on their real-time load.

The assignment follows the below overall architecture:



Below are the descriptions of each file that are used to implement the dynamic load balancing of EVs charge requests:

Folder	File	Logic(Process)
charge_request_service	main.py	Accepts charge requests and forwards them to load balancer
	Dockerfile	For containerizing main.py
load_balancer	main.py	Performs check on load of substations and routes the requests to least loaded substation
	Dockerfile	For containerizing main.py
substation_service	main.py	Tracks how many Evs are charging and simulates the substation
	Dockerfile	For containerizing main.py
load_tester	test.py	It sends multiple charging requests to charge_request_service
smart-grid-load-balancer	docker-compose.yml	This is the main orchestration file that defines all services & helps in network communication between services
monitoring/prometheus	prometheus.yml	This is a monitoring tool that captures the logs of Evs charging
monitoring/grafana	dashboard.json	Queries the metrics from prometheus

Below are the steps followed to complete the assignment:

- After preparing all the files I ran the command “docker-compose up --build” which created and started all the services defined in the docker-compose.yml file.

```

✓ api Built
✓ lb_svc Built
✓ sub1 Built
✓ sub2 Built
✓ Network smart-grid-load-balancer_default Created
✓ Container smart-grid-load-balancer-api-1 Created
✓ Container smart-grid-load-balancer-sub1-1 Created
✓ Container smart-grid-load-balancer-graf-1 Created
✓ Container smart-grid-load-balancer-prom-1 Created
✓ Container smart-grid-load-balancer-sub2-1 Created
✓ Container smart-grid-load-balancer-lb_svc-1 Created

```

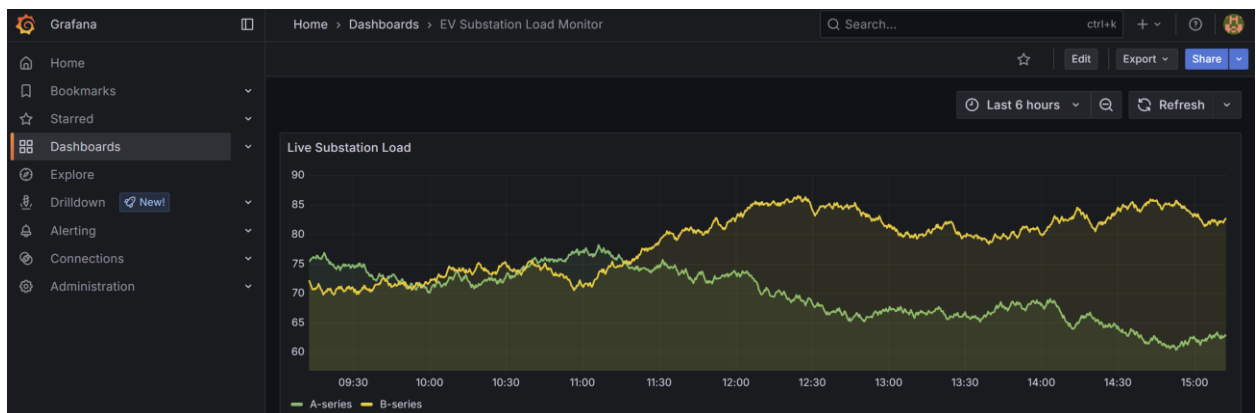
- Then I ran the python file “test.py” which sent multiple EVs charging requests to charge\_request\_service which forwarded the requests to load\_balancer that gets the load of each substation from substation\_service and allocates the charging request to least loaded substation.

```
PROBLEMS  OUTPUT  DEBUG CONSOLE  TERMINAL  PORTS

PS C:\Users\Kush\Downloads\smart-grid-load-balancer> cd load_tester
PS C:\Users\Kush\Downloads\smart-grid-load-balancer\load_tester> python test.py
Request 1: {'msg': 'Charging started'}
Request 2: {'msg': 'Charging started'}
Request 3: {'msg': 'Charging started'}
Request 4: {'msg': 'Charging started'}
Request 5: {'msg': 'Charging started'}
Request 6: {'msg': 'Charging started'}
Request 7: {'msg': 'Charging started'}
Request 8: {'msg': 'Charging started'}
Request 9: {'msg': 'Charging started'}
Request 10: {'msg': 'Charging started'}
Request 11: {'msg': 'Charging started'}
Request 12: {'msg': 'Charging started'}
Request 13: {'msg': 'Charging started'}
Request 14: {'msg': 'Charging started'}
Request 15: {'msg': 'Charging started'}

sub1-1 | 172.18.0.5 - - [23/Jun/2025 09:40:14] "POST /begin HTTP/1.1" 200 -
lb_svc-1 | 172.18.0.4 - - [23/Jun/2025 09:40:14] "POST /assign HTTP/1.1" 200 -
api-1 | 172.18.0.1 - - [23/Jun/2025 09:40:14] "POST /ev_charge HTTP/1.1" 200 -
sub2-1 | 172.18.0.5 - - [23/Jun/2025 09:40:14] "POST /begin HTTP/1.1" 200 -
lb_svc-1 | 172.18.0.4 - - [23/Jun/2025 09:40:14] "POST /assign HTTP/1.1" 200 -
api-1 | 172.18.0.1 - - [23/Jun/2025 09:40:14] "POST /ev_charge HTTP/1.1" 200 -
sub1-1 | 172.18.0.5 - - [23/Jun/2025 09:40:14] "POST /begin HTTP/1.1" 200 -
lb_svc-1 | 172.18.0.4 - - [23/Jun/2025 09:40:14] "POST /assign HTTP/1.1" 200 -
api-1 | 172.18.0.1 - - [23/Jun/2025 09:40:14] "POST /ev_charge HTTP/1.1" 200 -
sub2-1 | 172.18.0.5 - - [23/Jun/2025 09:40:14] "POST /begin HTTP/1.1" 200 -
lb_svc-1 | 172.18.0.4 - - [23/Jun/2025 09:40:14] "POST /assign HTTP/1.1" 200 -
api-1 | 172.18.0.1 - - [23/Jun/2025 09:40:14] "POST /ev_charge HTTP/1.1" 200 -
sub1-1 | 172.18.0.5 - - [23/Jun/2025 09:40:15] "POST /begin HTTP/1.1" 200 -
lb_svc-1 | 172.18.0.4 - - [23/Jun/2025 09:40:15] "POST /assign HTTP/1.1" 200 -
api-1 | 172.18.0.1 - - [23/Jun/2025 09:40:15] "POST /ev_charge HTTP/1.1" 200 -
sub2-1 | 172.18.0.5 - - [23/Jun/2025 09:40:15] "POST /begin HTTP/1.1" 200 -
lb_svc-1 | 172.18.0.4 - - [23/Jun/2025 09:40:15] "POST /assign HTTP/1.1" 200 -
```

- On accessing the Grafana dashboard below is the line chart generated as part of test.py execution which shows the load on each substation:



Video Link:

[https://drive.google.com/file/d/1EtVNdRVPxPMBfFefTPbv5LkOUaH20qPz/view?usp=drive\\_link](https://drive.google.com/file/d/1EtVNdRVPxPMBfFefTPbv5LkOUaH20qPz/view?usp=drive_link)

Conclusion:

As seen in the working of the dynamic load balancing of a smart grid, the system effectively distributes EV charging requests to the least-loaded substations. The system is also integrated with Prometheus & Grafana which helps in continuous monitoring of load in each substation's.

By,

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